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Planting Guidelines for Marsh Development and Bank Stabilization

by
Paul L. Knutson

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Marsh plants are effective in stabilizing eroding banks in many sheltered coastal areas. Exceptional results have been achieved in a variety of intertidal environments at a fraction of the cost required for comparable structural protection. Techniques are available for the efficient propagation of several marsh plants for use in bank stabilization. This report provides guidelines for (a) selecting plants and planting methods, (b) determining seed application rate and plant spacing, (c) determining fertilization
(continued)

requirements, and (d) estimating labor for planting on a project-by-project basis.

PREFACE

This report is a planting guideline for marsh development and bank stabilization. It is intended to augment information in Chapter 6 of the Shore Protection Manual (SPM) (U.S. Army, Corps of Engineers, Coastal Engineering Research Center, 1975).

The report was prepared by Paul L. Knutson, Coastal Ecology Branch, under the general supervision of R.M. Yancey. Illustrations were prepared by the author and L. Martin.

Comments on this publication are invited.

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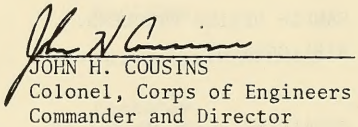

JOHN H. COUSINS
Colonel, Corps of Engineers
Commander and Director

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CONVERSION FACTORS, U.S. CUSTOMARY TO METRIC (SI)
UNITS OF MEASUREMENT

U.S. customary units of measurement used in this report can be converted to metric (SI) units as follows:

Multiply	by	To obtain
inches	25.4	millimeters
	2.54	centimeters
square inches	6.452	square centimeters
cubic inches	16.39	cubic centimeters
feet	30.48	centimeters
	0.3048	meters
square feet	0.0929	square meters
cubic feet	0.0283	cubic meters
yards	0.9144	meters
square yards	0.836	square meters
cubic yards	0.7646	cubic meters
miles	1.6093	kilometers
square miles	259.0	hectares
knots	1.8532	kilometers per hour
acres	0.4047	hectares
foot-pounds	1.3558	newton meters
millibars	1.0197×10^{-3}	kilograms per square centimeter
ounces	28.35	grams
pounds	453.6	grams
	0.4536	kilograms
ton, long	1.0160	metric tons
ton, short	0.9072	metric tons
degrees (angle)	0.1745	radians
Fahrenheit degrees	5/9	Celsius degrees or Kelvins[1]

[1]To obtain Celsius (C) temperature readings from Fahrenheit (F) readings, use formula: $C = (5/9)(F - 32)$.

To obtain Kelvin (K) readings, use formula: $K = (5/9)(F - 32) + 273.15$.

PLANTING GUIDELINES FOR MARSH DEVELOPMENT AND BANK STABILIZATION

by

Paul L. Knutson

I. INTRODUCTION

This report contains information which supplements Chapter 6 of the Shore Protection Manual (SPM) (U.S. Army, Corps of Engineers, Coastal Engineering Research Center, 1975)[1]. The objective of the report is to provide guidelines for the establishment of vegetation for marsh development and bank stabilization in coastal areas.

II. SELECTING PLANTS AND PLANTING METHOD

The appropriate species and planting method may be determined in the following manner.

STEP ONE: Select the description from each of the following categories which best describes the site to be planted.

GEOGRAPHICAL AREA

Atlantic coast
Gulf coast
Pacific coast (southern)

TIDAL ELEVATION

Mean low water (MLW) to mean tide level (MTL)
MTL to mean high water (MHW)
MHW to estimated highest tide (EHT)

TIDAL RANGE

0.0 to 3.0 feet (1.0 meter)
3.0 feet or greater

SALINITY

0 to 20 parts per thousand
21 to 40 parts per thousand
41 to 60 parts per thousand

---

[1]U.S. ARMY, CORPS OF ENGINEERS, COASTAL ENGINEERING RESEARCH CENTER, *Shore Protection Manual*, 2d ed., Vols. I, II, and III, Stock No. 008-002-00077-1, U.S. Government Printing Office, Washington, D.C., 1975, 1,160 pp.

FETCH LENGTH

0.0 to 1.0 mile (1.6 kilometers)
1.1 to 5.0 miles (8.0 kilometers)
5.1 to 10.0 miles (16.0 kilometers)

SOIL PROPERTIES

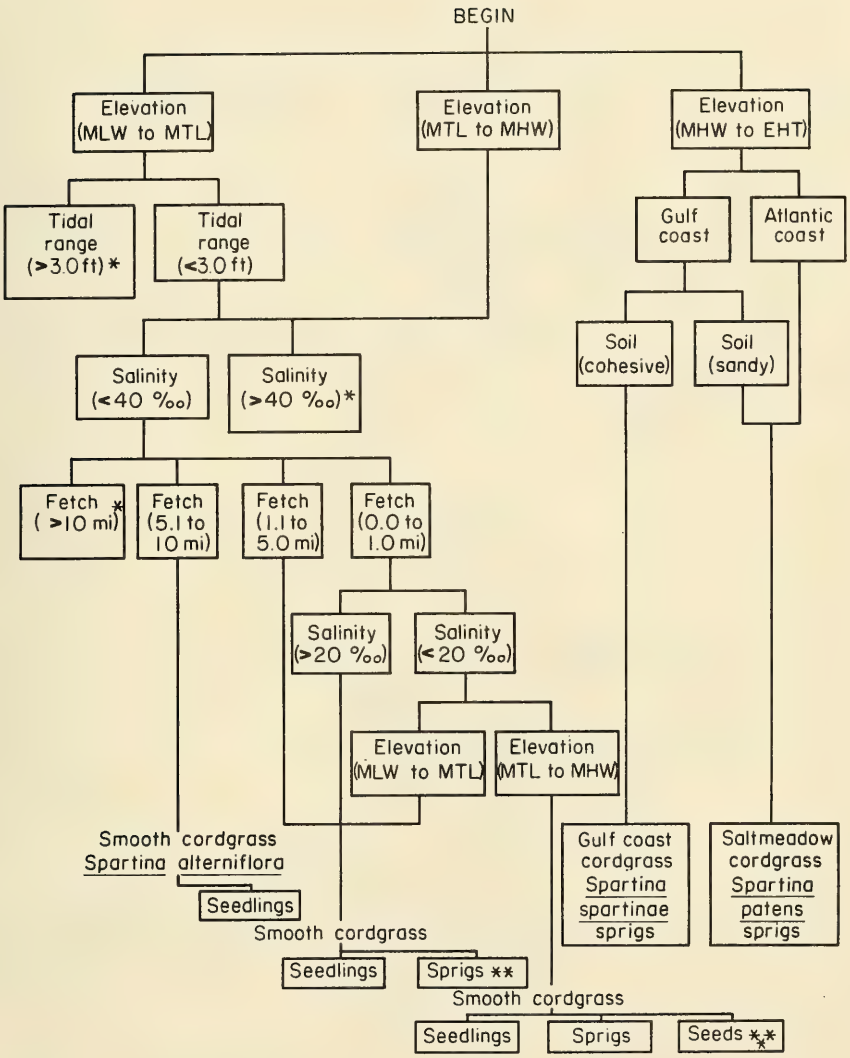
Mostly cohesive (silts and clays)
Mostly granular (sand)

Tidal elevations and tidal range can be estimated if detailed surveys are not available. To estimate tidal elevations, consult local tide tables and make site observations during low water and high water periods. Make these observations during calm periods when waves are low and there are no local storm fronts. Use reference stakes to delineate the tidal zone (MLW and MHW). Consider the midpoint between the high and low stakes to be MTL. *Tidal range* is the vertical difference between high and low water. Tide tables can be obtained from private distributors such as sporting goods stores, marinas, and fishing concessions, and from the U.S. Coast Guard and U.S. Geological Survey.

If specific information is not available, salinity can be estimated using the following general guidelines. Water begins to taste salty at about 3 parts per thousand. Seawater contains about 33 parts per thousand salt. In general, the waters of bays, sounds, and estuaries will have salinities lower than seawater because of the influence of freshwater. Salinity will be less than 20 parts per thousand in waters which are close to tributaries or are far from openings to the ocean. Salinity is likely to be more than 20 parts per thousand near bay mouths and inlet openings. Salinities greater than 40 parts per thousand are likely to be encountered only in areas where circulation is poor, evaporation rate is high, rainfall is low, and temperatures are high. Additional information on local salinity regimes is often available from State departments of natural resources, academic institutions, and the National Oceanic and Atmospheric Administration (NOAA).

Fetch length is the horizontal distance over which winds may blow across open water to create waves. Consider only the longest fetches.

STEP TWO: Turn to the planting decision key (Fig. 1 if site is located on the Atlantic or gulf coasts; Fig. 2 if on the Pacific coast). Using the appropriate planting decision key and the site description compiled in STEP ONE, begin at the top of the key and move downward following the appropriate path. The path will terminate in a block which either designates suitable plant species and planting methods or indicates the site is not appropriate for planting. Information on obtaining plant materials is in Appendix A; a description of each planting method is given in Appendix B; and maintenance requirements are discussed in Appendix C.

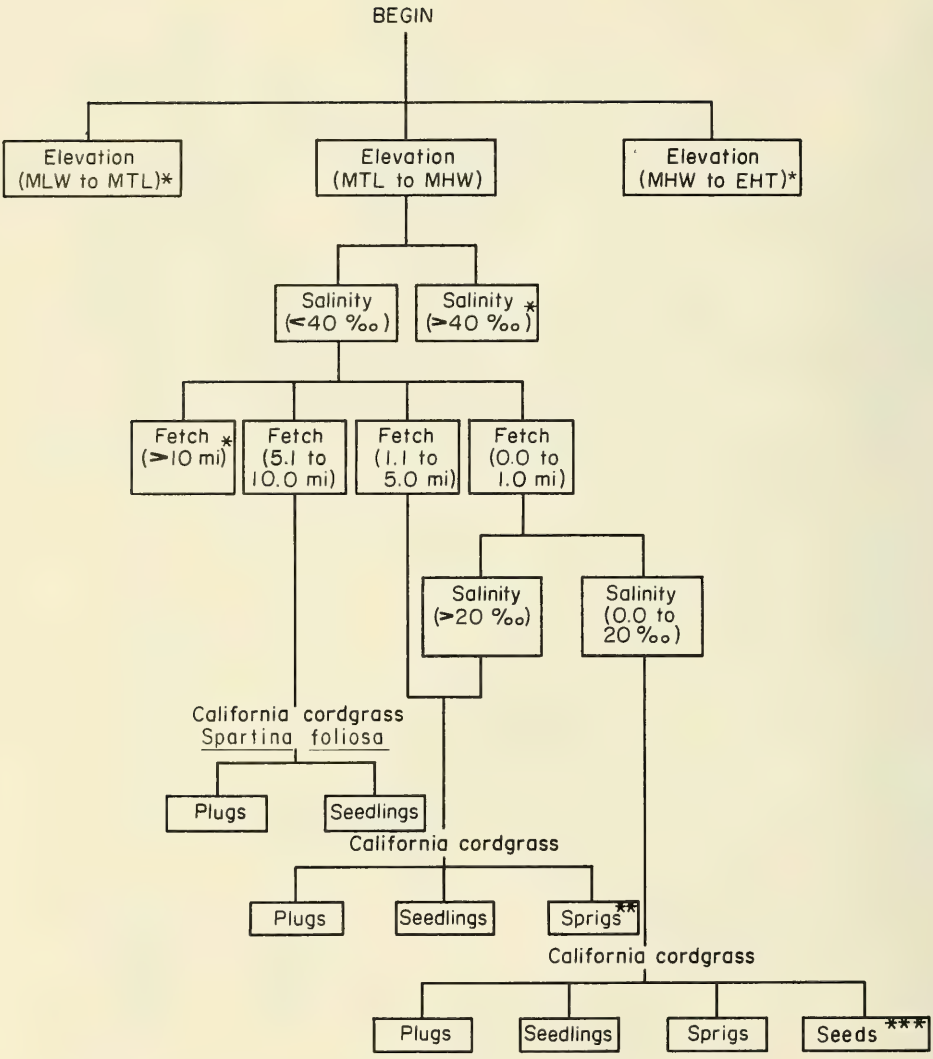


* Do not plant

** Least cost planting method

*** Least cost but not recommended for dredged material disposal area

Figure 1. Planting decision key, Atlantic and gulf coasts.



* Do not plant

** Least cost planting method

*** Least cost but not recommended for marsh development on dredged material

Note: Tidal range not a determining factor on Pacific coast

Figure 2. Planting decision key, Pacific coast.

III. DETERMINING SEED APPLICATION RATE AND PLANT SPACING

1. Seeding.

The recommended application rate for seed is given by:

$$\text{Seed application rate} = Ra \times Qs$$

where Ra is a base application rate of 2 gallons per acre (19 liters per hectare) of seeds for California cordgrass (*Spartina foliosa*) or 1 gallon per acre (9.5 liters per hectare) of seeds for smooth cordgrass (*S. alterniflora*), and Qs is the seed quality index for the seed source. Qs is approximated by collecting and examining seed before harvest. The total number of spikelets examined divided by the number of full spikelets (Fig. 3) is the Qs.

Figure 3. Full spikelet.

Threshing will reduce the volume of harvested material by about 50 percent. Therefore, the volume which must be harvested in anticipation of planting is:

$$\text{Harvest volume} = 2(Ra \times Qs) \times A$$

where A is the area to be planted in acres.

2. Sprigs, Plugs, and Seedlings.

The Table summarizes recommended plant spacing for marsh development projects (plant cover in three growing seasons) and for bank stabilization projects (cover in one to two seasons).

Table. Recommended plant spacing.

Plant material	Spacing for marsh development (in)	Spacing for bank stabilization (in)[1]
Smooth cordgrass (sprigs, seedlings)	36	18
California cordgrass (sprigs, plugs, seedlings)	36	18
Gulf coast cordgrass (sprigs)	36	36
Saltmeadow cordgrass (sprigs)	18	18

[1]Minimum width for bank stabilization planting is 10 feet.

The number of plants (sprigs, plugs, or seedlings) required for a given project is determined by:

$$\text{Plants required} = Pa \times A$$

where Pa is plants per unit area, based upon spacing requirements (18- and 36-inch spacing requires 19,400 and 4,840 plants per acre, respectively).

IV. DETERMINING FERTILIZATION REQUIREMENTS

Fertilization treatment is recommended for: (a) all bank stabilization projects, (b) situations where rapid plant cover is desired, and (c) all sandy planting areas.

1. Seeding.

Apply to surface two parts (by weight) ammonium sulfate or ammonium nitrate to one part treble-superphosphate. Fertilize with 200 pounds per acre (220 kilograms per hectare) in June and again in July of the first growing season (a total of 400 pounds).

2. Sprigs, Plugs, and Seedlings.

Apply to surface two parts (by weight) ammonium sulfate or ammonium nitrate to one part treble-superphosphate. Fertilize with 200 pounds per acre (220 kilograms per hectare) at time of planting and again in June (a total of 400 pounds) or side dress (work fertilizer into soil along one side of each plant) (1 ounce per plant), with 8- to 9-month release fertilizer at time of planting. Application rate per unit area for side dressing is dependent upon spacing requirements (18- and 36-inch spacing requires 1,200 and 300 pounds per acre, respectively).

Fertilization and other maintenance requirements are discussed in Appendix C.

V. ESTIMATING LABOR FOR PLANTING

1. Seeding. Seeding may be accomplished with about 25 manhours of effort per acre. This figure includes harvest, storage, dispersal, and tillage.

2. Sprigs. Sprigs may be excavated, separated, and planted for approximately 1 manhour per 100 plants. Labor per unit area is dependent upon plant spacing (18- and 36-inch spacing requires 200 and 50 manhours per acre, respectively).

3. Seedlings. Nursery seedlings will require about 5 manhours per 100 plants to prepare and plant. Labor requirements are: 18- and 36-inch spacing requires 1,000 and 250 manhours per acre, respectively.

4. Plugs. Plugs will require about 10 manhours per 100 plants to prepare and plant. Labor requirements are: 18- and 36-inch spacing requires 1,850 and 450 manhours per acre, respectively.

VI. SAMPLE DESIGN PROBLEMS

The following examples demonstrate the use of the guidelines presented.

* * * * * * * * * * * * * * EXAMPLE PROBLEM 1 * * * * * * * * * * * * * *

GIVEN: Type of project, marsh development; geographical area, Atlantic coast; tidal elevation, MTL to MHW; salinity, 15 parts per thousand; fetch length, 0.0 to 1.0 mile; seed quality index (Qs) = 2.

FIND: Plant and planting method.

SOLUTION: Refer to Section II and use Figure 1. The path compatible with this project terminates in a block indicating that smooth cordgrass seedlings, sprigs, or seeds are suitable. (Seeds are designated as the lowest cost method.)

FIND: Seed application rate.

SOLUTION: Refer to Section III.

$$\text{Seed application rate} = Ra \times Qs.$$

Base application rate (Ra) for smooth cordgrass is 1 gallon per acre (9.5 liters per hectare).

Qs is given as 2.

Therefore,

seed application rate = 2 gallons per acre.

* * * * * * * * * * * * * EXAMPLE PROBLEM 2 * * * * * * * * * * * * * *

GIVEN: Type of project, bank stabilization; size, 20-foot width and 435-foot length (0.2 acre); geographical area, Pacific coast; plant material, California cordgrass sprigs; plant spacing, 18 inches; fertilizer, top dressing.

FIND: Fertilization required.

SOLUTION: Refer to Section IV.

Application rate for top dressing is 400 pounds per acre.

Total fertilizer required for 0.1 acre is 40 pounds.

FIND: Labor requirements for planting.

SOLUTION: Refer to Section V.

Labor requirement per unit area for sprigs spaced 18 inches apart is 200 manhours per acre. Therefore, labor required for this project (0.2 acre) is 40 manhours.

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APPENDIX A

OBTAINING PLANT MATERIALS

Few companies specialize in the sale of salt marsh plants. Information concerning local suppliers may be obtained from the State agent of the U.S. Department of Agriculture, Soil Conservation Service located in State capitals. The following are known commercial distributors of salt marsh plants:

Horticultural Systems Inc.
P.O. Box 3
Bradenton, Florida 33506

Environmental Concern Inc.
P.O. Box P
St. Michaels, Maryland 21663
(301) 745-9620

San Francisco Bay Marine Research Center
8 Middle Road
Lafayette, California 94549
(415) 332-5100

Complete taxonsomic descriptions of the plants discussed in this report may be found in Hitchcock (1971)[2]:

Smooth cordgrass (*Spartina alterniflora*)

California cordgrass (*Spartina foliosa*)

Gulf coast cordgrass (*Spartina spartinae*)

Saltmeadow cordgrass (*Spartina patens*)

In addition, Figure A-1 provides simplified illustrations of these plants. Confusion in recognizing these three species is not likely. California cordgrass is found only on the Pacific coast; smooth cordgrass is common only on the gulf and Atlantic coasts; Gulf coast cordgrass is limited to the gulf. Where smooth cordgrass and Gulf coast cordgrass occur together, each can be distinguished by their characteristic habits. Smooth cordgrass will be found forming nearly homogeneous stands within the intertidal zone. Gulf coast cordgrass, on the other hand, will be found in the high intertidal zone and on coastal uplands growing in clumps or tufts in association with other plant varieties.

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[2]HITCHCOCK, A.S., *Manual of Grasses of the United States*, 2d ed., 2 Vols., Dover, New York, 1971.

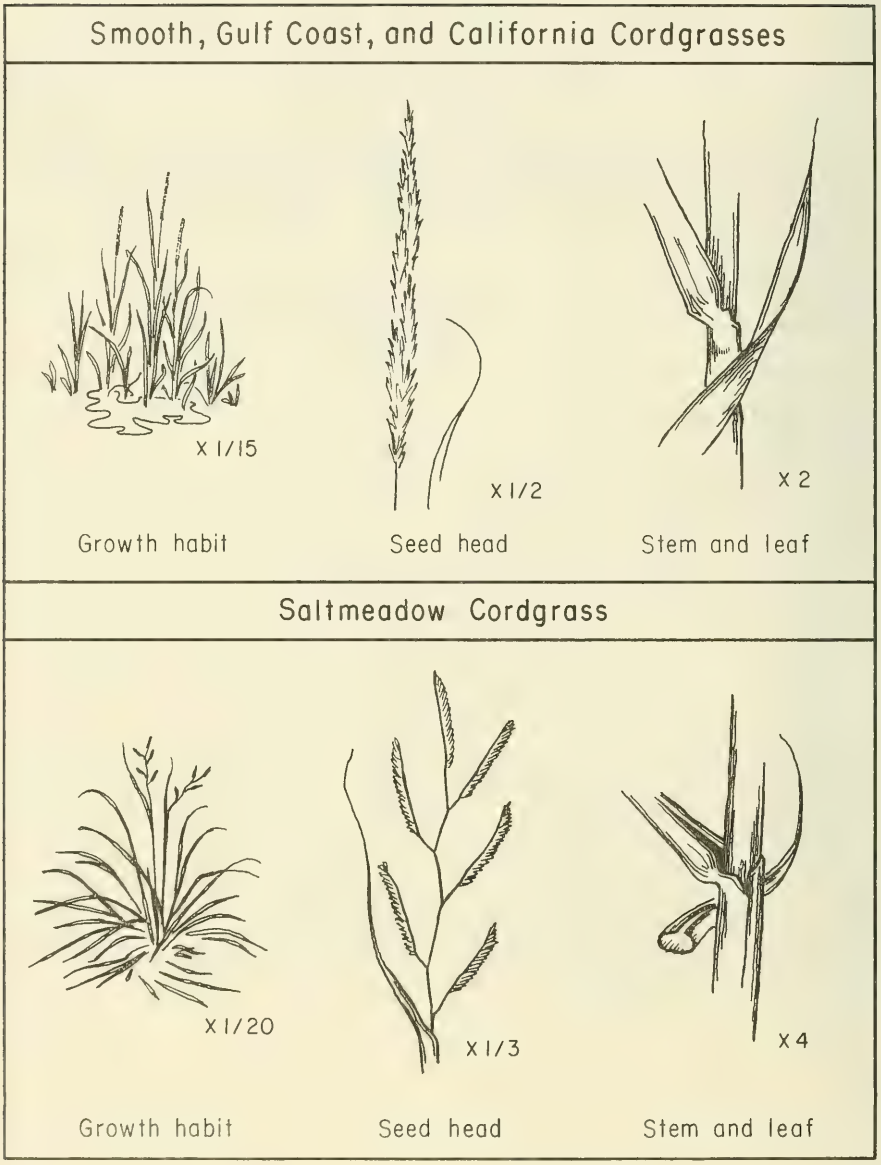

Figure A-1. Plant identification.

APPENDIX B

DESCRIPTION OF PLANTING METHODS

1. Site Preparation.

Planting areas should be sloped to 1 on 15 or less for seeding projects. Areas to be planted with sprigs, plugs, and nursery seedlings should be sloped as gradual as practicable.

2. Seeding.

Seeding is recommended for only smooth cordgrass and California cordgrass. Methods for planting these are similar. The seeds are ready for harvest as early as September in northern latitudes and as late as November in southern areas. Seed-producing stands should be examined periodically during appropriate months. When seeds are easily dislodged by grasping the seed head, harvesting should begin. To harvest, clip seed head from adult plant. After harvesting, store collected material 2 weeks in moist condition, thresh, and store in cold (39° Fahrenheit, 4° Celsius), brackish water. Broadcast at low water during late winter or spring (February through April in southern latitudes (south of latitude 37° N.) and March through May in northern latitudes. Cover seeds with one-half inch or less of tillage. Standard agricultural equipment may be used to harvest and broadcast seed. Generally, such equipment requires modification to achieve mobility in marsh substrates.

3. Planting Sprigs.

A sprigging technique can be used to plant all of the species discussed. A sprig is a part of a plant consisting of at least one node (joint of a stem from which the leaves arise) with attached stems and roots. To obtain sprigs, dig plants from existing marshes or "nurseries" established for this purpose and separate them. (CAUTION.--this activity is potentially damaging to existing, natural marshes. Avoid disruption of areas subject to erosion.) Obtaining and separating sprigs is much more efficient in sandy substrates and in young stands where dense root systems have not yet formed. Sprigs must be kept moist until planting and may be heeled-in (base of the plant covered with sediment but leaves and stems exposed) for several days in an intertidal area. (Do not allow plants to overheat by covering or keeping in closed containers.) To plant, open a hole 4 to 6 inches in depth, insert the sprig, and firm the soil. Early spring is optimal for planting, although moderate success can be obtained in other seasons. A modified tobacco planter may be used to increase planting efficiency on sandy sediments.

4. Planting Plugs.

Plugs may be used to plant California cordgrass. A *plug* is a root-soil mass, 4 to 6 inches (10 to 15 centimeters) in diameter and 6 to 8

inches (15 to 20 centimeters) deep which contains roots and a number of stems. Plugs can be excavated from existing marshes and transplanted intact. Collect plugs in cohesive sediments only. An intact root-soil sediment mass cannot be maintained in sandy sediments. Plugs may be planted during any season (except in areas with ice formation) though spring is preferable. Caution against disrupting natural marshes also applies here.

5. Planting Nursery Seedlings.

Smooth cordgrass and California cordgrass may be planted using nursery seedlings rooted in peat moss pots. Seedlings have a well-developed, intact root-soil mass for planting in either cohesive or sandy sediments. Seedlings have several advantages. Nursery stock can be (a) held indefinitely in the event of construction delays, (b) planted in most any season, though spring is preferred, and (c) cultivated with a minimum of disturbance to existing marshes. To prepare nursery seedlings, collect and store seed as discussed in Section II. Seeds may be stored up to 8 months. Remove seeds from storage and scatter over the surface of 3- to 5-inch-diameter peat moss pots filled with sand. Apply approximately 10 seeds per pot, scarify lightly, irrigate with tapwater, and apply 10-10-10 fertilizer at 0.25 ounce per square foot after seeds have germinated.

Seedlings should be grown for at least 3 months before planting. Maintain salinity in the solution comparable to that which will be encountered at the planting site. Planting of both plugs and seedlings is more efficient if holes are opened with an auger.

APPENDIX C

MAINTENANCE OF PLANTED OR SEEDED AREAS

1. Debris Removal.

Debris such as wood, styrofoam, algae, and dislodged submerged plants accumulate in the high marsh forming a strand line. This material may smother and damage plantings particularly during the first two growing seasons. This litter should be removed in both the fall and the spring.

2. Fertilization.

If plant cover and development are inferior to that desired by the second growing season, fertilize again at rate given in Section IV for seeded areas.

3. Waterfowl Control.

Canadian and Snow geese are fond of the tender roots and rhizomes of marsh plants and may destroy a planted area before establishment. Rope fences erected on the seaward edge of planted areas have been used successfully to exclude waterfowl during the first few growing seasons. The fences consist of wood, metal, or plastic pickets strung with 1/8-inch nylon rope. The ropes are spaced at 6-inch intervals from the sediment surface to an elevation above MHW.

Knutson, Paul.

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1. Marsh ecology. 2. Banks (Waterways). 3. Tidal marshes. 4. Aquatic plants. 5. Erosion control. I. Title. II. Series: U.S. Coastal Engineering Research Center. Coastal engineering technical aid. CETA 77-3.

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